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Report of activities on peatland research 1985

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On 2 June 1886, *The Experimental Farm Station Act* received Royal Assent. The passage of this legislation marked the creation of the first five experimental farms located at Nappan, Nova Scotia; Ottawa, Ontario; Brandon, Manitoba; Indian Head, Saskatchewan (then called the North-West Territories); and Agassiz, British Columbia. From this beginning has grown the current system of over forty research establishments that stretch from St. John's West, Newfoundland, to Saanichton, British Columbia.

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Research programs focus on soil management, crop and animal productivity, protection and resource utilization, biotechnology, and food processing and quality.

Report of activities on peatland research 1985

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ABSTRACT

This report of Activities summarizes a variety of work carried out by the Land Resource Research Institute, Agriculture Canada on peatland projects supported by the National Research Council (NRC) Peat Forum. The papers presented in this report are concerned with the characterization and analysis of peat in the field and in the laboratory.

There are four papers presented in the report. The first paper discusses the importance of botanical composition as a criteria for the classification of organic soils and suggestions for the incorporation of botanical composition into the classification system are presented. The second paper presents suggestions for the use of micromorphological techniques to describe and characterize organic soils and discusses how micromorphological data can be used to compliment field observations and analytical data. The third paper discusses the importance of quality control procedures (the standardization of analytical procedures and the use of organic soil reference samples) for the analysis of organic soils. As well the progress towards the development of six reference samples is outlined. The final paper is a summary of results and discussion of a workshop on field tests and field methods for organic soils. The importance of standardization of field tests and suggestions of the acceptable limits of variability were presented.

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SUMMARY

The physical and chemical characteristics of peat material are dependent upon the proportions and origins of the botanical constituents. The incorporation of botanical composition into a classification system for organic soils is desirable. The botanical origin is possibly the most widely used criterion in the classification of organic soils. However classes of botanical composition are not easily defined or well accepted. In the field only the identification of broad plant groups is possible. It is important that these plant groups be easily, consistently and reliably distinguished in the field with the aid of a hand lens. It is therefore desirable that these plant groups be adequately defined and mutually exclusive. An evaluation of the botanical composition of coastal British Columbia peat materials has been undertaken and a guide for estimating botanical composition in the field along with recommendations is forthcoming.

Micromorphological techniques can be used to describe and characterize organic soils and this micromorphological data can be used to compliment field observations and analytical data. During 1983 and 1984 the methodology for sampling and preparation of organic samples was refined, and a descriptive system for characterizing the micromorphology of organic soil was developed. The chemical and physical characteristics of forest humus overlying peat materials were examined.

Concerns have been expressed by many individuals representing numerous agencies for the need to develop reference samples for organic soils to be used in the testing and analyses of these soils. Each year thousands of pieces of data are produced from which numerous papers are published with little or no documentation of quality control procedures, or reference samples used during analysis. Often the assumption is made that the data reflects the capability of the process rather than the lack of control over it. During 1984 six bulk organic samples representing a cross-section of peat types and degrees of decomposition were collected. A field description of the materials is given and the progress towards the development of the six reference samples is outlined.

During the 1983 field season a workshop on field tests and field methods for organic soils was held. The participants evaluated six peat materials on the basis of von Post, rubbed fiber, pH and botanical composition. The objective was to assess the variability of the results of each test and provide a forum for discussion. The need for continual standardization of field tests and methods among agencies and persons collecting peatland data was demonstrated and acceptable limits of variability for some tests were suggested.

RÉSUMÉ

Les caractéristiques physiques et chimiques du matériel tourbeux dépendent de la proportion et de l'origine de ses constituants botaniques. Il est souhaitable d'ajouter la composition botanique au système de classification des sols organiques. L'origine botanique est sans doute le plus utilisé des critères de classification des sols organiques. Cependant, les classes de composition botanique sont difficiles à définir et mal acceptées. Dans ce domaine, seule l'identification des grands groupes de végétaux est possible. Il est important que ces groupes puissent être différenciés sur le terrain de façon constante, fiable et aisée à l'aide d'une loupe. Ces groupes de végétaux devraient donc, idéalement, être bien définis, sans recoupement possible. Une évaluation de la composition botanique du matériel tourbeux de la côte de la Colombie-Britannique a été réalisée et un guide d'estimation de la composition botanique sur le terrain, accompagné de recommandations, sera préparé sous peu.

Il est possible d'utiliser des techniques micromorphologiques pour décrire et caractériser les sols organiques; les données micromorphologiques peuvent compléter les observations sur le terrain et les données analytiques. En 1983 et 1984, on a perfectionné la méthode d'échantillonnage et de préparation des échantillons organiques et on a élaboré un système descriptif de caractérisation de la morphologie des sols organiques. On a aussi étudié les caractéristiques chimiques et physiques de l'humus forestier recouvrant le matériel tourbeux.

Beaucoup de personnes représentant de nombreux organismes ont parlé du besoin de mettre au point des échantillons de référence à utiliser dans les essais et les analyses des sols organiques. Chaque année, des milliers de données sont publiées dans de nombreux articles qui ne contiennent que peu de documentation - voire aucune - sur les méthodes de contrôle de la qualité ou sur les échantillons de référence utilisés au cours des analyses. Souvent, les données sont réputées refléter la capacité du processus utilisé plutôt que le manque de contrôle exercé sur ce dernier. Au cours de 1984, on a prélevé six gros échantillons organiques représentant une coupe transversale de différents types de tourbe ainsi que divers degrés de décomposition. L'ouvrage contient une description du matériel faite sur le terrain et donne un aperçu de la préparation des six échantillons de référence.

Au cours de la saison 1983 a eu lieu un atelier sur les tests et les méthodes utilisés sur le terrain pour les sols organiques. Les participants ont évalué six matériels tourbeux d'après la méthode von Post, la méthode des fibres frottées, le pH et la composition botanique. L'atelier avait pour but d'évaluer la variabilité des résultats de chacun des tests et de fournir une occasion de discussion. Les participants ont démontré qu'il est nécessaire de normaliser constamment les tests et les méthodes utilisés sur le terrain par les organismes et les personnes qui recueillent des données sur les tourbières et ils ont suggéré des limites de variabilité acceptables pour certains tests.

The Role of Botanical Composition in the Classification of Peat

Corinne J. Selby

Organic soil, or peat, represents an accumulation of 30% or more organic matter. Depending on the degree of decomposition and lithic contact organic matter must accumulate to a thickness of at least 40 - 60 cm in order to be classified as an organic soil (Canada Soil Survey Committee 1978). Conditions which favor the accumulation of slowly decomposing organic materials include blocked drainages, cold climate, constant high humidity (Dansereau and Segadas-Vianna 1952) and a shortage of the nutrients necessary for the organisms which bring about decomposition (Ogg 1939). Organic matter is derived from the successive growth of vegetation which accumulates as more or less disintegrated plant remains (Dachnowski 1920). The morphological properties of the peat are primarily a function of the botanical composition of the peat and the degree of alteration (decomposition) by microbial activities which is influenced by the nutritional state. The botanical composition of each peat strata also provides the key to the history of development of the peatland. Since each vegetaion unit occurs under a limited range of field conditions, if the plant cover that initiated the peat can be reconstructed from the plant remains the conditions at the time of deposition can be inferred.

Three characters are commonly used as the basis for classifying peat: 1) botanical composition, 2) decomposition, and 3) nutritional state (Kivinen 1977 in Clymo 1983). Decomposition is generally divided into three levels: a) little decomposed (fibric), b) moderately decomposed (mesic), and c) highly decomposed (humic). Although the limits of each level may vary, these three categories are commonly used as the chief basis for grouping organic soils (Canadian Soil Survey Committee 1978; Farnham & Finney 1965; U.S.D.A. classification as presented by Clymo 1983). It has been stated that a method using only three stages of decomposition is "easier to define, is reproducible, is unusually simple, and is exceedingly well adapted to a wide variety of uses" (Farnham & Finney 1965). This is certainly the case for the three levels of decomposition presented although in some cases they are defined by the von Post scale of humification which has ten levels and the definitions of von Post can result in ambiguous classes.

Three classes of nutritional status frequently referred to in the literature (oligtrophic, mesotrophic, and eutrophic) are also used as a primary basis for classification (Kivinen 1977 in Clymo 1983; Gore 1983; Ogg 1939; Farnham 1968; Ruuhijarvi 1983; and Botch & Masing 1983). Each class tends to be associated with a specific vegetation type but they are often used without any reference to the vegetation.

Botanical origin is also used as the basis for organic soil classification although classes of botanical composition are not so easily defined or well accepted. A great variety of plant species and site conditions combine to result in the accumulation of an extremely complex peat material. With increased decomposition, identification of the botanical composition becomes more difficult. Variations in the rate of decomposition can further complicate the evaluation of botanical composition -- wood, for example, decomposes very slowly whereas broad-leaves decompose relatively quickly

(Heal, et al. 1978). The complexity of the peat material is undoubtedly responsible for the variety of ways in which botanical composition has been incorporated into peat classifications.

The significance of both the genesis and sequence of peat materials to our understanding of the development and structure of organic deposits is evident in the numerous classifications which include botanical composition as a primary basis for grouping peat. Several classifications are briefly outlined below.

Dachnowski (1920) emphasizes the history of the peat deposit in his approach to classification of peat in the U.S.. The genesis and sequence of peat materials constitute the chief basis for grouping. The two primary divisions are water-laid and land-laid peat deposits. The latter is distinguished by the presence of roots in the mineral substratum as well as a botanical analysis of the peat materials themselves. No further classes are suggested but Dachnowski (1920) recommends that microscopic evaluation of the plant remains in peat deposits (as done by von Post) should be undertaken in order to "correlate the sequence of peat materials with alternating wet and dry periods whilch accompanied changes in climatic conditions."

The von Post scale of humification (in Clymo 1983) is widely used to estimate decomposition. The degree of decomposition, however, represented only one of several criteria regularly noted for each type of peat and used to describe the qualities of the deposits in Sweden (von Post 1937). Microscopic analysis was used to identify plant remains. Thirty kinds of peat were classified (e.g., Fuscum peat, Pine-moss peat, Magnocaricetum peat, etc.). Numerical scales for degree of humification, humidity, cotton grass fibres, rootlets and wood debris are used as modifiers.

Auer (1930) classified organic materials in the peat bogs of Canada according to origin and botanical composition. His eight classes are: (1) inorganic ooze, (2) organic ooze (limnetic), (3) limy ooze (limnetic), (4) jelly like ooze (limnetic), (5) Carex peat, (6) Amblystegium peat (telmatic), (7) Sphagnum peat, and (8) grass-herb-forest peat (terrestrial).

A classification system for commercial peat used in soil improvement and horticulture in the USA is presented by Farnham (1968). Generic origin and fibre content are used to calssify five major types of peat as: (1) Sphagnum moss peat (peat moss), (2) Hypnum moss peat, (3) reed-sedge peat, (4) peat humus, and (5) other peat. Non-commercial peats are not considered.

Kivinen (1977 in Clymo 1983) presents a commercial classification of Finnish peats in (Clymo 1983) in which botanical composition is a primary grouping key. Four peat types are distinguished: 1) moss peat (>75% moss, <10% wood), 2) herbaceous peat (>75% herbaceous plants, <10% wood), 3) wood peat (>35% wood), and 4) mixed peat (any other type).

Heinselman (963) adapted the terminology of Farnham (1956) and, with the addition of class 7, used the following classification to describe peat profiles in Minnesota: 1) aggregated or granular peat (muck), 2) amorphous (colloidal) peat, 3) herbaceous (fibrous) peat, 4) moss peat, 5) sedimentary (aquatic) peat, 6) woody peat, and 7) mixed moss-herbaceous peat. Peat profile descriptions were then grouped into four broad peat stratigraphy

classes based primarily on the dominant botanical composition in the profile. The stratigraphy classes recognized are: 1) *Sphagnum* peats, 2) Forest peats, 3) Non-forest sedge peats, and 4) Aquatic peats. These generalized classes were used to reconstruct the history of each peatland studied.

Botanical composition serves as the basis for peat identification in the USSR as well (Botch & Masing 1983). It is considered one of the main features determining nearly all properties of peat. However, it is used only at the sub-class and type levels of the classification -- nutritional status is the basis for the primary division. Using botanical composition, 39 original peat types (the basic unit of the classification) were recognized (Appendix 1). Sub-classes are based on the amount of wood in the deposit. A comparable classification has been developed for peat deposits using the thickness of each layer and the sequence of peat types in the deposit (Tyumremnov 1976 *in* Botch & Masing 1983).

In the Canadian Soil Taxonomy (CSS Committee, 1978) botanical composition is used only to distinguish one of the four great groups identified for the organic order. Forest leaf litter which is only briefly saturated has been separated from all other organic material which includes mosses, sedges, and other aquatic plants commonly saturated with water. However, the other three great groups are defined on the basis of the degree of decomposition with no mention of botanical composition, even at lower levels of the classification.

Eight peat types were defined for some Fraser Delta deposits in British Columbia (Styan 1981). The classes defined are: 1) Sedge-Clay, 2) Gyttja, 3) Sedge-Grass, 4) Sedge-Wood, 5) Sedge-*Sphagnum*, 6) *Nuphar*, 7) *Sphagnum* and 8) Ericaceous-*Sphagnum*. Detailed microscopic analysis was used to identify plant remains.

In a recent study of coastal peatlands, Moon (unpublished) recognized three organic layer classes based on field estimates of botanical composition: (1) Sediments, (2) sphagnum and (3) unidentifiable which includes varying combinations of sedges, rushes, or reeds, and sphagnum. Each class is subdivided on decomposition level. Organic deposit classes are based on the dominant layer classes with a greater emphasis on decomposition.

It is apparent from these brief descriptions of peat classifications developed around the world that the incorporation of botanical composition is not a straight forward process. The variety of plant materials from which peat is comprised is partially responsible for the problems encountered. It is difficult to determine what basis to use for grouping plant material - e.g., mode of deposition (aquatic vs terrestrial); nutritional status (acidic vs rich in nutrients - especially N); morphology (wood, moss, herb, mixed), etc. Each of these, along with various combinations have been used to classify peat material.

A problem which is fundamental to any use of botanical composition in the classification of peat is that of identification of plant remains. Detailed microscopic analysis is the most reliable means of identification and is assumed in most classifications but this has several inherent limitations. It cannot be done in the field and therefore extensive sampling is required. Relatively few people have the training required to identify microscopic plant remains so that it can be both time consuming and costly to get botanical

composition values for numerous samples. This necessarily implies that it is difficult to apply in a routine inventory. Furthermore, although it is possible to identify some pollen grains, seeds, and leaves to the generic or even the species level, it is extremely difficult to distinguish many species unless the appropriate floral and vegetative parts are present. Since this is generally not the case, even detailed microscopic analysis may not provide reliable estimates of botanical composition.

Even if it was possible to obtain consistent microscopic evaluations of botanical composition, the question remains of how well they reflect the vegetaion from which the peat forms and how reliable they are. Variations in the rates of decomposition mean that more resistant plant materials will be identifiable and recorded while readily decomposed plants are totally ignored. Unfortunately, identifiable remains are generally presumed to be the source of peat no matter what proportion they actually represent (something that cannot always be determined). Although decay resistant materials often do contribute to the peat composition, even this is not necessarily the case. Wind carried pollen can be deposited in peatlands from adjacent upland or marginal plants which do not actually grow on the developing peat material. Pollen is quite resistant to decomposition and may inadvertantly be included in the record of botanical composition for a peat layer. This can lead to an inaccurate picture of peat development.

Identification of botanical composition in the field must be based on gross morphological characteristics. A study to evaluate botanical composition was undertaken in conjunction with research to characterize and classify the peatlands of coastal B.C. (Tarnocai 1982; Moon 1982, and Selby and Moon 1982). Field estimates of percent Sphagnum, sedge, moss, brown moss, wood, sedimentary peat, amorphous, seeds, charcoal and other were recorded by Tarnocai (personal communication 1982). Percent Sphagnum moss, brown moss, feather moss, forest litter, wood, sedges, roots, unidentifiable fiber, sedimentary organic materials, and amorphous organic materials was recorded in the field by Moon (1982) for each distinct layer in the peat profile. (Moon (personal communication) expressed a lack of confidence in the distinction between mosses in any but fibric materials and also found that unidentifiable fibre predominated in mesic materials). A small sample (2 cm^3) from each peat layers was collected for observation under a dissecting microscope. Lab estimates of botanical composition will be based on a maximum magnification of forty times. More detailed evaluation is considered inappropriate because the objective of the study is to determine suitable botanical groupings for field estimation. It is desirable that the number of botanical groupings be few enough to be adequately defined, mutually exclusive and reliably distinguished in the field, with the aid of a hand lens.

Preliminary indications are that only broad plant groupings can be reliably distinguished. The most consistent estimates of composition are for relatively undecomposed (fibric) peat where large fragements of plant material are observed. With increasing decomposition the distinction between plant materials becomes tenuous. Remaining identifiable plant fragments are few, of relatively small size and may in fact represent only a minor portion of the vegetation from which the peat formed. It is apparent that detailed estimates of botanical composition must be used with extreme caution. An evaluation of the botanical composition of coastal British Columbia peat should be completed early in 1985. Recommendations and a guide for estimating botanical composition in the field will be presented at that time.

The incorporation of botanical composition into a classification of organic soils may present some problems in evaluation, however, the information gained from a knowledge of the botanical origins of peat far outweigh the difficulties in its application. Peat morphology, nutritional status, and, to a certain extent, degree of decomposition are a function of the botanical composition. It is no wonder that "botanical origin is perhaps the most widely used criterion in organic soil classification" (Farnham & Finney 1965). A major concern must be how reliably botanical composition is determined and how well estimates of composition can be interpreted to infer conditions at the time of deposition. The challenge is to integrate botanical composition into a classification of organic soils in such a way that it can be easily, consistently, and reliably evaluated in the field.

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Appendix 1

Peat Classification Used in the U.S.S.R.
as presented by Tyumremnov 1976 in Botch and Masing 1983

EUTROPHIC PEAT CLASS

Wood peat group
- alder peat
- birch peat
- spruce peat
- pine peat
- willow peat

Wood-graminoid peat group
- wood-sedge peat
- wood-reed peat

Wood-moss peat group
- wood-Bryales peat
- wood-*Sphagnum* peat

Graminoid peat group
- horsetail peat
- reed peat
- sedge-reed peat
- *Menyanthes* peat
- sedge peat
- *Scheuchzeria* peat

Graminoid-moss peat group
- sedge-Bryales peat
- sedge-*Sphagnum* peat

Moss peat group
- Bryales peat
- eutrophic *Sphagnum* peat

MESOTROPHIC PEAT CLASS

Wood peat group
- mesotrophic wood peat

Wood-graminoid peat group
- mesotrophic wood-sedge peat

Wood-moss peat group
- mesotrophic wood-*Sphagnum* peat

Graminoid peat group
- mesotrophic sedge peat
- cotton-grass-sedge peat
- mesotrophic *Scheuchzeria* peat

Graminoid-moss peat group
- mesotrophic sedge-*Sphagnum* peat

Moss peat group
- mesotrophic Bryales peat
- mesotrophic *Sphagnum* peat

OLIGOTROPHIC PEAT CLASS

Wood peat group
    oligotrophic pine peat
Wood-graminoid peat group
    pine-cotton-grass peat
Wood-moss peat group
    pine-Sphagnum peat
Graminoid peat group
    cotton-grass peat
    Scheuchzeria peat
Graminoid-moss peat group
    cotton-grass-Sphagnum peat
    Scheuchzeria-Sphagnum peat
Moss peat group
    Sphagnum fuscum peat
    Sphagnum magellanicum peat
    complex peat
    hollow peat

Research Activities Applying Micromorphological Techniques To Characterizing Organic Soil Materials

Catherine A. Fox

ABSTRACT

Micromorphological techniques facilitate the description of the fabric of soil materials. For organic soils, the arrangement of the fragments and the associated voids can be described and characterized. The morphological data can be used to complement information obtained from field observations and analytical inventory data.

During 1983 and 1984, sampling of peat materials and forest humus for micromorphological analyses was undertaken. The methodology for sampling and preparation of organic samples was refined and a descriptive system for characterizing the micromorphology of organic soils was developed.

The chemical and physical characteristics of forest humus overlying peat materials were examined. Micromorphological characterization of peat materials and forest humus will continue in 1985.

INTRODUCTION

Field examination of peat materials with the Canadian Wetland Registry system of description (Tarnocai, 1980) provides information, such as estimates of botanical composition, decomposition (von Post and rubbed fiber estimates) and structure, on the macromorphology of the peat materials. Field observations of the macromorphology of peat materials are restricted by the scale at which observations can be made (<10x magnification with a hand lens). This initial level of description often provides little information on the arrangement and characteristics of the individual organic fragments composing the peat material. The stereomicroscope and the light microscope facilitate observations at magnifications ranging from low (<25x) to high (<125x), thus providing a means to obtain additional data about the arrangement and structure of the organic particles.

This report will outline the ongoing and planned activities for characterizing the micromorphology of organic materials. The main emphasis of this research will be on describing the fabric at low magnifications in order to maintain continuity of description between field observations of the macromorphology and the micromorphology.

Field Sampling:

Undisturbed samples which are representative of the horizons and profile being described are required for micromorphological examination. For peat materials, a Macaulay peat auger is used to retrieve a relatively undisturbed peat core from the surface of the peat to the underlying mineral material (Eagle, 1983). This core of peat material is subsampled for micromorphological examination according to the following methodology: Half

cylinders of plastic PVC tubing (diameter 3.75 cm and length 15 cm) were prepared for use with the Macaulay augers (diameters 3.6, 4.5, 5.0 cm). Larger or smaller lengths of PVC tubing could also be used but the 15 cm length provided sufficient sample for thin section preparation (microscope slides 2 cm x 3 cm) and was an appropriate size for field transportation as well as shipping. The plastic tube was labelled to indicate sample number, depth, layer or horizon, and orientation; placed in a plastic bag to prevent moisture loss; covered with a 0.5 cm thick plywood lid, tightly wrapped with masking tape, and, labelled once more with sample number, layer and horizon, and depth.

Laboratory Preparation:

An essential part of preparation of organic materials for the production of thin sections is the removal of water from the sample prior to impregnation with polyester resins or epoxides which are immiscible with water. The water is exchanged with an organic solvent such as acetone either by capillary exchange or by vapour exchange (Sheldrick, 1984). Removal of the water from the sample by air drying usually results in severe shrinkage, which causes the destruction of the morphology of the organic material as it existed in the field. Once the samples have been impregnated, thin sections are prepared by cutting the impregnated sample, mounting on microscope slides (i.e. 2 x 3 cm) and grinding to 30μm thickness. The methodology is outlined in Sheldrick (1984).

Descriptive System for Characterizing the Micromorphology:

A descriptive system was developed for characterizing the micromorphology of organic materials in thin sections (Fox, 1984). Available descriptive systems were limited with regard to describing the variability of fabrics observed at changing magnifications.

Distinct regions of morphology (fabric zones) that are composed of a particular arrangement and combination of organic components can be delineated in each thin section. Four main types of components referred to as basic morphologic units were recognized and a code letter assigned as follows: particulate materials, P; granular units, G; discrete compound particles, C; and massive-appearing fabric, M. The four main types of basic morphologic units can be further distinguished with a lower case letter to identify the composition as follows: p, plant fragments; a, amorphous (unrecognizable) organic materials; m, mineral material, and g, granular material. Each recognized fabric zone is recorded by writing the observed components in order of decreasing dominance. For example, [PpGaMg] describes a zone of morphology with three components, recognizable plant fragments, Pp; amorphous granular units, Ga; and massive-appearing fabric resulting from a dense packing of granular units, Mg. The symbol designating the zone of morphology is referred to as a fabric unit. The fabric units are written in order of decreasing occurrence (areal proportion of the fabric zone in the thin section). This written format is referred to as a fabric description symbol. For example, [GaMa] [Cap], indicates that in the thin section there were two fabric zones observed: the first and dominant fabric zone designated by the fabric unit [GaMa] consists of amorphous granular units, Ga, together with dense amorphous

material, Ma; the second fabric unit [Cap] describes a region of morphology consisting entirely of discrete compound particles composed of both amorphous material and plant fragments.

Additional detail can be added to the fabric description symbol with indices and symbols to indicate the following:

1) Quantitative measurements of the areal proportions of the fabric zones and the individual basic morphologic units:

2) Boundary relationships between adjacent fabric zones, and

3) Specific data about the features or characteristics of a particular fabric zone or basic morphologic unit.

Because codes and symbols are used to represent the components and fabric zones, the fabric description symbols provide the means to record at any magnification the observed morphology so that comparisons can be facilitated between fabric zones, thin sections, layers or horizons and pedons. In addition, a data base can be established so that comparisons and interpretations can be made between organic soils from widely varying environments.

Forest Humus Overlying Peat Materials:

Tarnocai (1983) noted that peat deposits occurred under upland forest materials and that such landscape relationships required further investigation. Samples were taken along a transect (Fig. 1) that included a site with forest humus overlying peat materials. Table 1 presents some of the chemical and physical analyses of the forest humus (sampling site 1) and the peat material (sampling site 3). The forest humus (Hr) tends to have a lower pH value than the peat materials, high unrubbed fiber and rubbed fiber, lower pyrophosphate solubility index and slightly higher exchangeable Ca and Mg. The location of the forest humus tends to be on the higher points in the landscape in relation to the peat materials (Fig. 1). This higher elevation suggests that improved drainage exists at the surface providing aerobic conditions for the growth of trees. The acid soil environment may contribute to the maintenance of the accumulation of forest materials over the peat materials. Radiocarbon dating indicated that the forest humus has been present at this site (Fig. 1) for approximately 980 years.

To better understand the nature of the forest humus, detailed description and sampling were undertaken on forest humus materials at selected areas. Table 2 presents a profile description of a site near Prince Rupert, British Columbia where thick accumulations of forest humus overlay peat materials (Fig. 2). The chemical and physical characteristics are presented in Table 3. The forest humus in comparison to the peat material tends to have slightly lower values of percent carbon, lower pyrophosphate solubility index, and increased amounts of exchangeable Ca and Mg especially in the surface 20 cm where vegetative root growth is abundant. Radiocarbon dating indicated that the accumulation of forest humus began approximately 1930 $\pm$ 350 B.P. and the peat materials 8570 $\pm$ 100 B.P. Samples for micromorphological examination will be prepared in 1985.

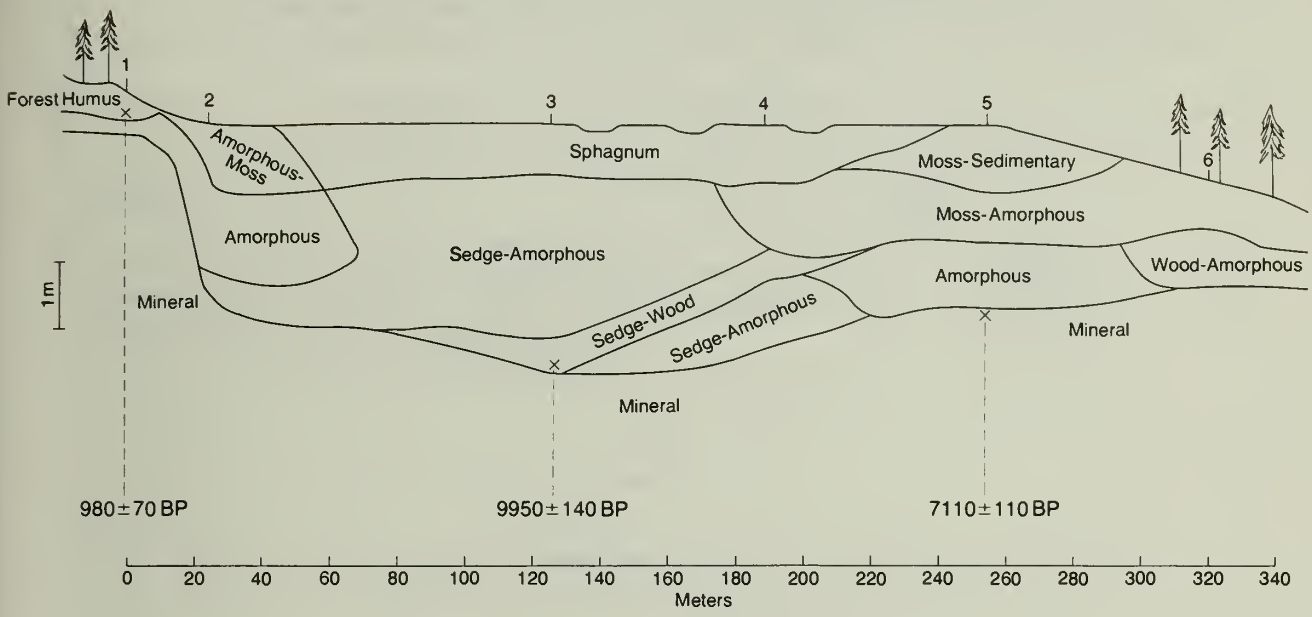

FIGURE 1: Cross-section of a slope bog on Finlayson Island (54°34'5" Lat., 130°28'45" Long.) showing peat materials and radio carbon dates.

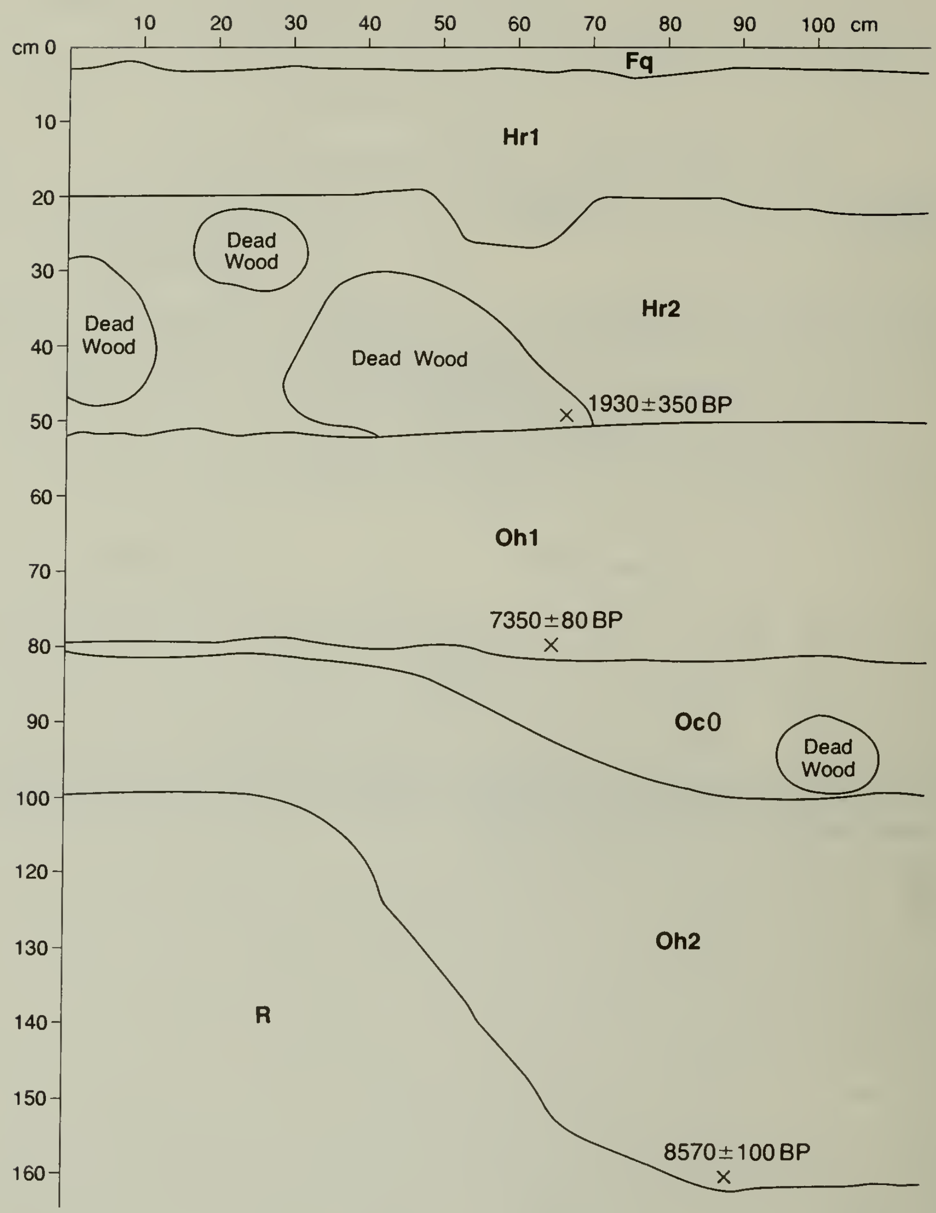

FIGURE 2: Diagrammatic sketch of organic soil with forest humus overlying peat materials near Prince Rupert (54°14'5" Lat., 130°4'5" Long.).

Activities Planned for 1985

Activities for 1985 will include the preparation of 170 samples obtained from various peatlands in British Columbia and Ontario as well as samples of forest humus overlying peat materials. The thin sections will be used as follows:

1) to assess the variability in composition and arrangement of the organic particles between different kinds of peat materials and forest humus

2) to compare the morphology of peat materials from different environments,

3) to complement morphological descriptions obtained from field inventory surveys, and

4) to examine the fabric of the organic materials at low magnifications and determine if specific characteristics are suitable for classification of the different peat materials.

Table 1: Chemical and physical analyses of Sites 01 and 03 on a transect of a slope bog on Finlayson Island (50° 34' 15"N Lat., 130° 28' 45"W Long.).

Site	Horizon	Depth (cm)	pH 1:2 .01M $CaCl_2$	% C	% N	% Ash	% Pyrophosphate Sol. index	% Unrub. Fiber	% Rub. Fiber	2N NaCl Exchangeable Cations (me/100g) Ca	Mg	K	Al	Calorific value (cal/g)
01	Hr	0-45	2.6	50.6	0.89	1.85	8.3	80	42	7.7	12.2	1.2	0.9	5730
	Oh	45-59	-	53.1	0.76	2.81	29.4	46	8	4.7	8.9	1.1	2.2	5984
03	Of	0-78	3.2	48.1	0.49	2.00	8.8	78	20	10.6	13.4	0.5	2.3	6276
	Om1	78-275	3.3	46.7	0.95	1.40	20.9	82	12	15.9	9.2	0.2	2.3	5646
	Om2	275-311	3.8	54.5	0.67	2.70	14.2	86	20	44.7	6.5	0.2	1.3	5896
	Oh	311-369	4.6	48.7	1.25	13.60	93.1	52	1	68.4	6.7	0.2	1.7	5612
	Cg1	369-381	5.1	2.0	0.08					7.6	0.6	0.3	0.0	-
	Cg2	381+	5.9	1.1	0.06					25.3	2.7	2.2	-	-

Table 2: Profile Description of an Organic Soil with Forest Humus overlying peat materials. (Site Location: Prince Rupert Area: 54° 14' 5"N Lat. 130° 4' 5"W Long.)

Horizon	Depth (cm)	Description
F_q	0-3	Dark reddish brown (5YR 2.5/2) wet; loose fibrous forest humus, weak non-compact matted; common very fine to medium horizontal roots; common randomly distributed fungi; gradual smooth boundary; acid (4.5).
Hr1	3-20	Very dusky red (2.5YR 2.5/2) wet; forest humus; weak non-compact matted to fine granular; friable; abundant very fine to coarse horizontal roots; gradual wavy boundary; acid (3.0).
Hr2	20-52	Very dusky red (2.5YR 2.5/2) wet; forest humus, moderate blocky; firm, greasy; plentiful fine to coarse horizontal roots; common medium to coarse fragments of decaying wood; acid (2.8).
Oh1	52-82	Black (5YR 2.5/1) wet; sedimentary - amorphous peat, very soft, massive; greasy; gradual wavy boundary; acid (2.8).
Oco	82-99	Dark reddish brown (5YR 3/3); sedge-sedimentary peat; hard massive; greasy; few rootlets; gradual, wavy boundary; acid (3.0).
Oh2	99-151	Dark reddish brown (5YR 3/2); sedimentary moss-sedge peat; massive; non-sticky; very few rootlets; clear to abrupt boundary; acid (3.5).
R	151+	

Table 3: Chemical and physical characteristics of organic soil with forest humus overlying peat materials.

Horizon	Depth (cm)	pH 1:2 .01M $CaCl_2$	% C	% N	% Ash	% Pyrophos-phate Sol. index	% Unrub. Fiber	% Rub. Fiber	2N NaCl Exchangeable Cations (me/100g) Ca	Mg	K	Al	Calorific value cal/g	Na-Pyro phosphate Extractable %Fe	%
Fq	0-3	4.5	44.9	1.00	8.03	7.2	86	44	53.6	5.1	2.0	0.4	5199	0.02	0.0
Hr1	3-20	3.0	49.3	1.06	3.02	9.2	80	40	22.0	6.0	1.2	1.2	5588	0.01	0.0
Hr2	20-52	2.8	48.9	1.06	3.22	32.1	60	12	4.8	9.4	0.8	2.6	5782	0.06	0.1
Oh1	52-81	2.8	54.2	0.75	3.94	169.5	26	2	2.4	2.0	0.3	9.1	5937	0.02	0.3
Oco	81-99	3.0	52.1	0.93	7.83	60.6	68	12	2.8	1.0	0.3	11.6	5658	0.01	0.5
Oh2	99-151	3.5	45.5	1.39	17.99	65.2	78	10	2.9	0.8	0.3	11.1	5438	0.01	1.3
R	151+														

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Quality Control and the Development of Six Organic Soil Reference Samples

A.E. Eagle

INTRODUCTION

Concerns have been expressed by many agencies across Canada for the need to develop reference samples for use in the analysis of organic soils and to begin a process of standardizing the methods of analyses. Each year dozens of papers are published with little or no documentation on analytical procedures used and on reference materials or other quality control procedures employed. This makes comparisons between paper difficult and often of little consequence. The objectives of this paper are to first emphasize the need for laboratory quality control in terms of precision, accuracy and bias; second to provide a brief history of the use of standard samples in soil survey laboratory analyses; and third to detail the collection and development of six organic soil standards.

Laboratory Quality Control:

Each year thousands of pieces of data are produced from soil survey laboratories, from which numerous papers are published. Rarely documented are the analytical procedures and reference materials used, or the quality control procedures used to ensure the quality of the data within test runs, between test runs, over time and between different operators.

The assumption is often made that the data reflects the capability of the process rather than lack of control over it. Control is required over both the range of variation of individuals values (precision), and the variation or drift of averages (accuracy).

Precision is the repeatability of a process or procedure and the reproducibility of the result. As long as the conditions of measurement are unchanged and the process has demonstrated to be rugged (relatively unaffected by small changes in procedure), one should expect, more-or-less, the same result every time the process is repeated assuming on average that small random effects on the result will tend to cancel out. However, even if precision can be maintained it does not ensure there is control. Prerequisities for precision are well-defined procedures and properly trained staff.

Accuracy is a measure of the deviation of an average from an expected value. Accuracy is relative, and to become accurate and remain accurate requires acceptable limits to be set and accessed on a continual basis. Repeated measurement will increase confidence in the average value obtained but, has no effect on the truth or accuracy of the average. It may in fact only verify any bias which may be present.

Bias is the variation of an average, either between operators, between systems/methods, or over time relative to an expected value. Bias is usually introduced through operator error (King 1976). For example, two different operators may both be precise and accurate but have different bias causing values to deviate from an expected value in different directions.

If resources are tight, precision control is less crucial. It is already limited by the analytical process and the technical proficiency of the staff. Accuracy, however, requires the implementation of active control procedures because of the nature of the human decision-making process.

Accuracy can be achieved using well-defined calibration and standardization procedures. Standardization by the use of properly prepared, traceable standards, and by the control charting of values over time. Precision, bais, and accuracy can only be assessed in terms of, past experience, continuing control, and a definition of what is considered acceptable.

Quality Control in Soil Laboratories:

In 1973, the Canada Soil Survey Committee (CSSC) approved the recommendation of the Subcommittee on Benchmark Soils that reference soil samples be collected for use in comparing analytical data among laboratories (Day and Lajoie, eds 1973).

Samples were collected representing both the vast geographic range and the wide variations of soils that occur in Canada. Analysts were encouraged to use the CSSC reference samples as in-run checks in their respective laboratories, and were requested to send the data for the CSSC samples for compilation. 'Best values' were compiled and analysts were informed particularly when results were markedly different from those obtained by most other analysts.

In 1981 the Expert Committee on Soil Survey (ECSS) set up a Quality Control and Methods of Analyses working group whose objectives are to investigate ways of improving quality control procedures and the uniformity of laboratory data. Some of the proposals presented are summarized as follows (Haluschak 1982):

1) To update and compile a list of laboratories that should be involved in standard sample analyses. A brief outline of methods used in laboratories would also be compiled.
2) To collect and distribute additional standard samples and to use a standard sample as a check with every batch analyses. To periodically distribute unknown samples for analyses.
3) To compile error values for methods of analyses.
4) To review and standardize methods which are presently used, but are not included in the methods manual.

Between 1982 and now there has been some discussions concerning quality control, however, implementation of control measures has not been a priority item. What is required is that the concern for data quality become a "priority" on the agenda of soil survey unit heads and laboratory supervisors. Although, quality control procedures are time consuming to implememnt and difficult to police the need to maintain credibility through the production of good quality data far outweigh the cost.

Organic Soil Standards:

The supply of the two CSSC organic soil reference samples (CSSC 13 - Typic Fibrisol, CSSC 14 - Typic Mesisol) have long been depleted. Without the use of standard reference samples (within-batch and between-batch analyses) there is no means available to access data quality, or to compare data between laboratories. With this in mind a program was initiated toward developing reference samples for use in the analysis of organic soils.

Materials and Methods:

During 1984 six bulk organic samples were collected each weighing Napproximately 150 Kg (wet).0 These samples represent a wide cross-section of peat types and degrees of decomposition. Four samples were collected in Ontario, one in Quebec, and one in British Columbia. Field description of the samples and of the profiles from which they were taken is given in Appendix I tables 1 to 6.

Subsamples of each have been kept moist (field state) for fiber determination while the remainder was air-dried and ground to pass a 2 mm sieve. The samples are stored at the Land Resource Research Institute in Ottawa. Subsamples will be sent to analysts wishing to cooperate in the comparison of data and use the reference samples as checks with batch analyses of organic soils.

Ten replicates of each sample have been submitted to the Land Resource Research Laboratory in Ottawa for analyses. Values for the following properties are to be determined:

pH H20
pH $CaCl_2$
% Carbon
% Nitrogen
Exchangeable Cation (2N NaCl) Ca, Mg, K, Al
Total Cation Exchange $Ba(OAc)_2$
Rubbed Fiber
Unrubbed Fiber
% Ash
Pyrosphosphate Index
Calorific Value
Sulphur
Atomic Absorption (minor elements) Co, Cu, Mn, Ni, Pb, Sr, Zn
Al, Ca, Fe, K, Li, Mg, Na

The analytical methods are those which are presently used in the Land Resource Research Institutes analytical service laboratory in Ottawa, and are outlined in the Analytical methods manual 1984., Land Resource Research Institute, B.H. Sheldrick, editor.

As the data becomes available it will be compiled from which tentative "best values" will be generated and distributed. Bulk samples will be supplied upon request.

It is important to realize that summary statistics can be calculated for any available data set. For example, the suitability of the standard deviation for predicting the likely range of deviation from an average requires that the results were determined under identical conditions and that the distribution of the results is approximately "normal". In other words, there must be control of quality. There is a need for continual in-laboratory and between laboratory quality control measures.

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Appendix I

Table 1: Field Description of Typic Mesisol - Reference Sample No. 1

Location: 31G/06 45° 24' 24" Latitude (N) 75° 27' 53" Longitude (W)
Classification: Typic Mesisol
Reference Sample No: Mesic peat material collected from 50-150 cm below the peat surface.

Horizon	Depth (cm)	
Om1	0-23	Dark reddish brown (5YR 3.0/2.0 m); moss-amorphous peat material; von Post 6; rubbed fiber 10%; pH 4.4; strongly granular; clear smooth boundary.
Om2	23-50	Dark brown (7.5YR 3.0/2.0 m); amorphous-sedge peat material; von Post 5; rubbed fiber 20%; pH 4.7; moderately layered; gradual smooth boundary.
Om3	50-220	Dark reddish brown (5YR 2.5/2.0 m); sedge-amorphous peat material; von Post 6; rubbed fiber 10%; pH 5.3; weakly fibered; abrupt smooth boundary.
2Cg	220+	Greenish grey (5BG 5.0/1.0 m); silty clay; pH 7.1.

Table 2: Field Description of Typic Mesisol - Reference Sample No. 2

Location: 31F/01 45° 14' 15" Latitude (N) 76° 3' 38" Longitude (W)
Classification: Typic Mesisol
Reference Sample No. 2: Mesic peat material collected from 50 cm - 100 cm below the peat surface.

Horizon	Depth (cm)	
Om1	0-35	Very dark gray (10YR 3.0/1.0 m); amorphous peat material; von Post 5; rubbed fiber 15%; pH 6.5; moderately granular; gradual smooth boundary.
Om2	35-325	Very dark grayish brown (10YR 3.0/2.0 m); sedge peat material; von Post 4; rubbed fiber 35%; pH 6.7; strongly fibered; gradual smooth boundary.
Om3	325-430	Very dark grayish brown (10YR 3.0/2.0 m); amorphous-sedge peat material; von Post 4; rubbed fiber 35%; pH 6.6; moderately fibered gradual smooth boundary.
Om4	430-545	Very dark grayish brown (10YR 3.0/2.0 m); sedge peat material; von Post 5; rubbed fiber 35%; pH 6.9; moderately fibered; clear smooth boundary.
Om5	545-640	Very dark gray (10YR 3.0/1.0 m); wood-amporphous peat material; von Post 6; rubbed fiber 15%; pH 6.7; moderately fibered; clear smooth boundary.
2Cg	600+	Dark Greenish gray (5.0 GY 4.5/1.0 m); sand; pH 6.9.

Table 3: Field Description of Typic Fibrisol - Reference Sample No. 3

Location: 31G/05 45° 27' 15" Latitude (N) 75° 55' 19" Longitude (W)
Classification: Typic Fibrisol
Reference Sample No. 3: Fibric peat material collected from 30-100 cm below the peat surface.

Horizon	Depth (cm)	
Of1	0-30	Dark brown (7.5 YR 3.0/2.0 m); moss-sphagnum peat material; von Post 3; rubbed fiber 80%; pH 4.4; strongly fibered; clear smooth boundary.
Of2	30-160	Dark reddish brown (5.0 YR 3.0/4.0 m); sphagnum peat material; von Post 3; rubbed fiber 80%; pH 4.6; strongly fibered; clear smooth boundary.
Of3	160-215	Dark brown (7.5 YR 3.5/4.0 m); sedge-moss peat material; von Post 3; rubbed fiber 80%; pH 4.7; strongly fibered; clear smooth boundary.
Oco1	215-275	Dark brown (7.5YR 3.0/3.0 m); sedge-sedimentary peat; von Post 8; rubbed fiber 5%; pH 5.0; weakly fibered; gradual smooth boundary.
Oco2	275-500	Dark reddish brown (5.0YR 3.0/3.0 m); sedimentary peat material; von Post 9; rubbed fiber 2%; weakly layered; gradual smooth boundary.
Oco3	500-815	Dark brown (7.5YR 3.0/2.0 m); sedimentary peat material; von Post 9; rubbed fiber 1%; moderately layered; gradual smooth boundary.
2Cg	815+	Dark greenish gray (5.0GY 4.5/1.0 m); silty clay; pH 7.1.

Table 4: Field Description of Limno Humisol - Reference Sample No. 4

Location: 92 B/13 48° 54' 25" Latitude (N) 123° 31' 54" Longitude (W)
Classification: Limno Humisol
Reference Sample No. 4: Humic peat material collected from 55-100 cm below the peat surface.

Horizon	Depth (cm)	
Oh	0-55	Dark reddish brown (5.0YR 2.5/2.0 m); amorphous peat material; strongly granular; clear and smooth boundary.
Oco1	55-155	Dark reddish brown (5.0YR 2.5/2.0 m); sedimentary peat material; von Post 9; rubbed fiber 1%; pH 6.8; layered weakly; diffuse boundary.
Oco2	155-400	Dark olive gray (5.0YR 3.0/2.0 m); sedimentary peat material; von Post 9; rubbed fiber 1%; pH 7.1; layered weakly; diffuse boundary.
Oco3	400-571	Dark olive gray (5.0YR 3.0/2.0 m); sedimentary peat material; von Post 10; rubbed fiber 1%; pH 7.5; layered weakly; diffuse boundary.
Cg	571	Greenish gray (5GY 5.0/1.0 m); silty clay; pH 7.7.

Table 5: Field Description of Fibric Humisol - Reference Sample No. 5

Location: 30L/14 42° 54' 40" Latitude (N) 79° 18' 58" Longitude (W)
Classification: Fibric Humisol
Reference Sample No. 5: Fibric peat material collected from 20-70 cm below the peat surface.

Horizon	Depth (cm)	
Of	0-80	Dark reddish brown (5.0YR 3.0/3.0 m); sphagnum peat material; von Post 3; rubbed fiber 70%; pH 4.6; strongly fibered; clear smooth boundary.
Oh	80-210	Dark reddish brown (5.0YR 3.0/2.0 m); moss-amorphous peat material; von Post 7; rubbed fiber 8%; pH 4.9; weakly fibered; diffuse boundary.
Om	210-315	Dark reddish brown (5.0YR 2.5/2.0 m); sedge-amorphous peat material; von Post 5; rubbed fiber 15%; moderately fibered; diffuse boundary.
Cg	315	Gray (5.0YR 5.0/1.0 m); silty clay; pH 6.0

Table 6: Field Description of Typic Mesisol - Reference Sample No. 6

Location: 31 D/02 44° 08' 28" Latitude (N) 78° 57' 44" Longitude (W)
Classification: Typic Mesisol
Reference Sample No. 6: Mesic peat material collected from 25-100 cm below the peat surface.

Horizon	Depth (cm)	
Oh	0-25	Black (5.0YR 2.5/1.0 m); amorphous peat material; von Post 7; rubbed fiber 9%; pH 6.4; moderately granular; gradual boundary.
Om1	25-205	Dark reddish brown (5YR 3.0/2.0 m); amorphous-wood peat material; von Post 5; rubbed fiber 15%; pH 6.8; weakly granular; diffuse boundary.
Om2	205-305	Dark reddish brown (5YR 3.0/2.0 m); moss-amorphous peat material; von Post 6; rubbed fiber 10; pH 6.8; weakly fibered diffuse boundary.
Om3	305-390	Dark reddish brown (5YR 3.0/2.0 m); moss-amorphous peat material; von Post 5; rubbed fiber 15%; pH 6.8; weakly fibered diffuse boundary.
Ck	390-540	Dark grayish brown (10YR 4.0/2.0 m); marl; pH 7.0
Cg	540	Gray (5YR 5.0/1.0 m); loam; pH 7.1

Evaluation of Results Obtained During a Workshop On Field Tests and Field Methods For Organic Soils

D.J. Kroetsch

INTRODUCTION

As part of the Land Resource Research Institute Workshop on Field Tests and Sampling Methods for Organic Soils (May 19-20, 1983) six peat samples were collected as test materials to be evaluated in the field by the workshop participants. The six peat samples were collected from sites in the Ottawa area to represent fibric, mesic and humic peat materials. Estimates of the von Post scale of humification, field rubbed fiber, field pH (using dual pH paper) and botanical composition were made by the workshop participants on three of the soil samples each day. A summarization of the results of the first days testing was presented to each participant prior to the determinations for the second day and problems with the test methods were identified and discussed.

The objective of this exercise was to familiarize the participants with some of the field tests being used to describe peat and to determine the variability of results associated with each test. It was also hoped that problems associated with the field tests would be identified and this would demonstrate the need for standardization of field procedures. Suggestions for acceptable levels of variability were discussed for each test.

PEAT SAMPLES

Sample 01 was collected in the Albion Road Swamp, (0-100 cm) a basin swamp with a tree cover of Acer rubrum, Populus tremuloides, Betula papyrifera and Thuja occidentalis. A site description records the soil classification as a Terric Humic Mesisol. The peat material is described as a wood amorphous (forest) peat underlain by a sedge (fen) peat and marl (Tarnocai, 1981). The determinations of field pH, rubbed fiber and von Post recorded on the Canadian Wetland Registry Input Document No. 05-82-03-01 for horizons Oh and Oh_2 (0-96 cm) are; pH 4.8 and 6.0, rubbed fiber 5% and von Post 7 and 8 respectively.

Samples 02 and 05 were collected in the Gatineau Bog, (0-50 cm and 0-60 cm respectively) a basin bog with a Larix laricina, Picea mariana, Chamaedaphne calyculata, Ledum groenlandicum and Sphagnum spp. cover. Sample 02 (von Post 3-4, rubbed fiber 80%) was collected from the treeless center portion of the bog and was determined to be a fibric sphagnum peat. Sample 05 was collected from a treed portion of the bog and determined to be a fibric sphagnum peat, slightly more humified than sample 02. These soils have been classified as Typic Fibrisols.

Sample 03 was collected from the Osgoode Swamp (0-120 cm) a stream swamp with a cover of Populus tremuloides, Acer rubrum, Alnus rugosa and Spiarea alba. The soil classification for this site is a Typic Mesisol and the peat material is described as a wood amorphous peat underlain by a sedge amorphous peat. The field estimates of pH, rubbed fiber and von Post were; pH 6.3 and 6.8, rubbed fiber 5% and 16% and von Post 6 and 7 respectively for the Oh and Om horizons sampled (Canadian Wetland Registry Input Document No. 05-83-04-04).

Sample 04 was collected from the Mer Bleue Bog (100-150 cm) a basin bog with a Chamaedaphne calyculata, Ledum groenlandicum, Vaccinium myrtilloides and Sphagnum spp. cover. Tarnocai (1981) classified the soil at an adjacent site as a Typic Mesisol, Sphagnic phase and described the peat material as a sphagnum peat underlain by a sedge fen peat.

Sample 06 was collected in the Winchester Swamp (50-150 cm) a peat margin swamp with a shrub cover of Spiarea alba, Salix spp. and Cornus stolonifera. The soil classification recorded in the Canadian Wetland Registry Input Document No. 05-83-05-06 is a Typic Mesisol and the peat is described as a wood amorphous peat underlain by an amorphous sedge peat (30% amorphous, 60% sedge composition). The pH is 5.4, rubbed fiber 35% and von Post 05, for the Om horizon sampled.

RESULTS AND DISCUSSION

The range, mean and standard deviation of the field estimates of pH, rubbed fiber and the von Post scale of humification, were calculated and are summarized in Table 1. Laboratory determinations of pH (air dry samples) and rubbed fiber are included for comparison.

Field pH:

The summmarized field estimates of pH have the least variability of the three field tests. The range of standard deviations for field pH estimates is 0.22 to 0.56 units. The range of standard deviations for the von Post estimates and the estimates of field rubbed fiber are 0.89 to 1.44 and 8.81 to 18.76 respectively.

There is a decrease in variability of pH estimates for samples 04, 05 and 06 (samples evaluated during the second day). A possible explanation for this observation could be that the summarized results of the first days test were discussed prior to the second days testing and the problems individuals were having using the pH paper were corrected.

It is interesting to note that when the mean field pH values are compared to laboratory determinations of pH (air dry ground samples), the results are not the same. Samples 02 and 05, Sphagnum peat materials have laboratory pH values significantly lower than there mean field pH values. Samples 01, 03 and 06 wood amorphous peat materials have pH values significantly higher than the mean field pH values. The process of air drying, grinding and sample storage appears to alter the pH of the peat from that of the field estimates.

von Post:

Compared to the field estimates of pH the field estimates of the von Post scale of humification had the next greatest variability. By rounding off the mean estimates of the von Post scale of humification for the six samples, sample 04 (H=7) is in the humic range, samples 01 (H=6), 03 (H=6), 05 (H=4) and 06 (H=5) are in the mesic range and sample 02 (H=3) is in the fibric range. Again there is a decrease in variability during the second day of testing, possibly due to the discussion of the first day summarized results. The participants were also familiar with the correct techniques by the second day.

Table 1: The range, means and standard deviations calculated for the estimates of field pH, von Post scale of humification and field rubbed fiber, and also laboratory values of pH and rubbed fibers for six peat samples.

Sample No.	Location of Sample	Sample Depth (cm)	Field pH Range	Field pH Mean	Field pH Std. Dev.	Lab pH (Dry sample)	von Post Range	von Post Mean	von Post Std. Dev.	von Post H	Field rubbed fiber Range	Field rubbed fiber Mean	Field rubbed fiber Std. Dev.	Lab R.F.
01	ALBION	0–100	4.7–5.9	5.10	0.32	5.9	3–8	5.79	1.44	6	5–80	18.96	18.76	14
02	GATINEAU	0–50	3.0–4.8	4.25	0.46	3.4	1–8	3.04	1.20	3	50–95	82.17	10.51	78
03	OSGOODE	0–120	4.7–7.1	5.40	0.56	5.3	4–8	6.04	1.17	6	3–60	15.78	11.67	19
04	MER BLEUE	100–150	3.9–5.8	4.76	0.30	5.0	3–9	7.14	1.42	7	5–60	20.24	14.51	14
05	GATINEAU	0–60	3.8–4.8	4.24	0.29	3.6	3–7	3.57	0.95	4	55–85	72.38	8.81	70
06	WINCHESTER	50–150	4.7–5.5	5.12	0.22	5.6	4–8	5.33	0.89	5	10–70	26.33	13.88	18

Table 2: A summarization of peat material descriptions (based on Botanical Composition) and the number (percent) of participants using each description.

Sample 01 Albion Road Swamp

DESCRIPTION	NO.	%
Amorphous peat	7	30
Wood amorphous peat	4	17
Wood moss peat	2	9
Wood peat	2	9
Wood-brown moss peat	1	4

Sample 02 Gatineau Bog

DESCRIPTION	NO.	%
Sphagnum peat	6	27
Sedge sphagnum peat	4	18
Sedge peat	2	9
Amorphous sphagnum peat	1	5

Sample 03 Osgoode Swamp

DESCRIPTION	NO.	%
Amorphous peat	4	18
Wood amorphous peat	3	14
Sedge amorphous peat	3	14
Sedimentary-amorphous peat	1	5
Moss amorphous peat	1	5
Brown moss amorphous peat	1	5
Wood moss peat	1	5
Wood sedge peat	1	5

Sample 04 Mer Bleue Bog

DESCRIPTION	NO.	%
Amorphous peat	6	29
Sedge amorphous peat	5	24
Wood amorphous peat	3	14
Brown moss amorphous peat	1	5
Sphagnum amorphous peat	1	5
Moss amorphous peat	1	5

Sample 05 Gatineau Bog

DESCRIPTION	NO.	%
Sphagnum peat	15	75
Wood Sphagnum peat	3	14
Amorphous Sphagnum peat	1	5

Sample 06 Winchester Swamp

DESCRIPTION	NO.	%
Wood amorphous peat	8	38
Moss amorphous peat	3	14
Sedge amorphous peat	3	14
Sphagnum amorphous peat	1	5

Field Rubbed Fiber:

From the summarization of the estimates of field rubbed fiber, the large degree of variability of this procedure can be seen. For example sample 01 had a mean value of 18.96(%) and a standard deviation of 18.76, estimates ranging from 5-80%. Due to the entirely subjective nature of this test, this procedure would seem to be the least reliable.

The mean estimates of field rubbed fiber indicate that samples 01, 03, 04 and 06 are within the mesic range of rubbed fiber (10-40%) and samples 02 and 05 are fibric peats (rubbed fiber >40%). Laboratory determination of fiber contents also characterizes samples 01, 03, 04 and 06 as mesic peats and samples 02 and 05 as a fibric peat.

It would seem that due to the large degree of variability, the field rubbed fiber is useful in the field to place a peat material into the range of humic, mesic or fibric. However, the final designation of a horizon should be verified with laboratory rubbed fiber determinations.

Botanical Composition:

The identification of the botanical components of the peat samples (and the estimate of the percent of the sample they constitute) was the final determination. Table 2 represents the summary of the variable estimates of botanical composition and the ability of the workshop participants to identify the dominant botanical component(s) of each sample.

Table 2 is a summarization of the peat material descriptions and the number of participants describing the peat material (according to one of the descriptions) for each sample. The peat material description is based upon the estimated percent of each botanical component and which is present in the greatest percent volume or which is dominant. For example, if a participant described the botanical composition of a sample as sedge - 50%, wood - 30% and moss - 20%, the peat material is a woody sedge peat. Sedge describes the dominant botanical component and woody the subdominant or minor component.

From the summary of the descriptions of peat materials (Table 2) for sample 01, Albion Road Swamp, 47% of the participants identified the dominant component as amorphous and 30% described the subdominant component as wood. Seventeen percent described the sample as a wood amorphous peat.

Sample 02, Gatineau Bog is described as dominantly sphagnum by 50% of the participants and 27% described the subdominant component as sedge.

Thirteen (13) of the participants (59%) described sample 03, Osgoode Swamp as having a dominantly amorphous composition and 20% identified the subdominant component as wood.

From the Table 2 summary of peat material descriptions 81% of the participants identify the amorphous component as dominant and sedge was identified as the subdominant component by 25%. The peat material is described as a sedge amorphous peat by 25% of the participants.

Ninety (90) percent of the workshop participants described sample 05, Gatineau Bog, as a dominantly sphagnum peat and 71% described the sample as having a greater than or equal to 75% sphagnum composition.

Sample 06 collected from the Winchester Swamp is described as an amorphous dominant peat by 71% of the participants and as a (subdominant) wood peat by 42%. The peat material is described as a wood amorphous peat by 38% of the participants.

Therefore for all six samples the participants were able to identify the dominant botanical component. There was a greater difficulty identifying the subdominant botanical component which demonstrated the need to become more familiar with the botanical constituents of peat to be better able to recognize and describe the botanical components.

SUMMARY

Comparing the summarized results of field pH, von Post and rubbed fiber, field pH appeared to be the test with least variability. There seemed to be an increase in variability as the tests became more subjective or qualitative. Field pH is the more quantitative test, the comparison of the dual strip pH paper to a numbered scale, yielding an estimated pH value. The von Post estimate of degree of humification is more subjective or qualitative in nature requiring the interpretive analysis of the colour of the water squeezed from the sample, the amount of peat escaping between the fingers when the sample is squeezed and the structure of the sample remaining in the hand compared to a descriptive scale (Appendix I). The estimate of percent field rubbed fiber is entirely a qualitative evaluation requiring the identification and estimate of percent volume of various plant fiber remains.

The identification of the botanical constituents of a peat sample and their percent volumes is also a totally qualitative field estimate. This estimate requires the ability to recognize and identify plant remains in various stages of decomposition and to be able to consistently estimate their percent volumes. There appeared to have been a problem identifying the various botanical components. There is a tendancy to identify botanical remains as amorphous not only because it is unrecognizeable but also because it is unknown.

It appears that for all estimates the variability decreased for the second day of testing. The discussion of the first days summarized results and the problems associated with each testing procedure may explain this observation. Also by the second day of testing the participants were familiar with the correct methodology for each of the tests and had some experience working with peat and identifying various botanical remains.

This workshop was beneficial in that it helped identify the variability associated with the field testing procedures (estimates) and which method gives the most consistent information. The results of this workshop allow comparison and ultimately standardization of field techniques for uniform data collection among various researchers.

A number of recommendations and suggestions resulted from discussions during this workshop. The suggestions will hopefully aid in this standardization procedure.

SUGGESTIONS

Field pH:

It is important that the reactive portion of the pH paper does not come in contact with the skin (fingers), therefore the paper should be pushed into the peat sample with a clean stick or a piece of the peat being sampled. If the peat sample is very wet the reading should be taken very quickly before the diagnostic colour can be leached or washed out by the excess water. The peat sample may be very dry and not react with the pH paper, this may necessitate rewetting the sample with distilled water.

It was suggested that the field pH test using dual pH paper is accurate plus or minus 0.5 pH units.

von Post scale of humification:

This procedure should be standardized periodically throughout the sampling season, amongst the persons sampling the peat in the same region or those exchanging data. Also this procedure should be done in conjunction with a descriptive scale (Appendix I) several times until the tester is familiar and confident with the method.

Rubbed fiber:

For the estimation of field rubbed fiber this procedure should be standardized against the syringe method of fiber determination (Day, 1981) periodically throughout the sampling season and amongst the person doing the sampling.

Botanical composition:

For the recognition and identification of botanical remains and the estimation of their percent volume, the person describing the peat should make sure they are familiar with the various plant materials which may constitute a peat soil. The use of a hand lens may improve the recognition, identification and estimation of percent volume of the botanical components in a sample.

Hopefully the findings and suggestions presented in this workshop will demonstrate the need for, and aid in the standardization of peat testing methods to facilitate the transfer of information regionally and nationally.

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APPENDIX I

von Post Scale of Humification:

The von Post method is a field test used to estimate the stage of decomposition (H-value) of peat. The H-value is determined by squeezing a sample of fresh peat within the closed hand and observing the colour of the solution that is expressed between the fingers, the nature of the fibers, and the proportion of the original sample that remains in the hand. The degree of decomposition remains (H-value) is measured on an ordinal scale with ten classes defined as follows:

H-Value

01 - Living moss layer. Usually the surface 2-4 cm. Cannot be considered "peat", as it is still living.

02 - The structure and form of the plant material is complete. The only difference between H_1 and H_2 is that an H_2 peat is not living. When squeezing, clear to slightly yellowish water is emitted. The peat sample in the hand is normally bright yellow-orange in colour, especially after squeezing. The sample is spongy, or elastic - upon squeezing, the compressed sample springs back, and will take little or no shape.

03 - The plant material is still very easily distinguishable, but the individual Sphagnum "stalks" are breaking up into pieces, as opposed to continuous lengths of stems, etc. When squeezing, yellow water with some plant debris (mostly individual leaves) are emitted. The colour of the sample is somewhat darker than an H_2 peat. The sample is still spongy, but less than H_2 - after squeezing, the peat will spring back to a point where a vague to fairly definite form of the handprint in distinguishable.

04 - The plant material is not as easily distinguishable as in H_3 because the "pieces" of peat, as mentioned above, are now disintegrating, therefore you are often dealing with individual stems, branches, and leaves. When squeezing, light brown to brown water and alot of debris is emitted. The sample is not spongy, and upon rubbing, a slightly soapy or humic texture is detected. Upon squeezing, the sample makes a perfect replica of the handprint, commonly called "brass knuckles". It should be noted that after squeezing a peat sample, the difference in shape between an H_3 and H_4, is that an H_3 is "rounded off" as opposed to the definite "sharp" ridges left by the fingers on an H_4 sample. No peat escapes the fingers.

05 - The plant material is reaching a stage of decomposition where the individual components (branches, leaves, stems) are now starting to break up, such that, some amorphous, or unstructured material is present. When squeezing, definite brown water is emitted. This water is reaching the point where it can no longer be termed "water", but is a definite solution. The sample has a more definite soapy, or humic texture, yet roughness is still present. Upon squeezing a very small amount of the sample escapes between the fingers.

06 - The plant material has decomposed to the extent where almost half of the sample is in an amorphous or unstructured state. Plant constituents are still distinguishable upon close examination in the hand. Upon squeezing, brown to dark brown water is emitted. The sample is pasty and very malleable. Upon squeezing, approximately one-third of the peat escapes between the fingers as a paste.

07 - The original plant material is practically undistinguishable and a very close examination in the hand is needed to see that there are still vague structures present. If the sample is "worked" in the hand, this structure will disappear. It should be noted that such things as wood, sedge roots, and Eriophorum fibres are often very resistant to decomposition, and can be present in their "original" state of humified peats up to H_7. Upon gentle squeezing, a small amount of very dark water is emitted. When the final squeeze is performed, over half of the material escapes the hand.

08 - The only distinguishable plant remains are roots and/or Eriophorum fibres, when present. If appreciable amounts of roots or fibres are present, the peat cannot be considered to be an H_8, even though the remaining material is such. The "appreciable amounts" of these materials occurs when they interfere with the squeezing out of the remaining amorphous material. If actual wood "pieces or chips" are present in the sample, regardless of the amount, this alone classifies the peat as an H_7. Little or no water is emitted upon gentle squeezing. The final squeeze results in over two thirds of the peat escaping the hand.

09 - A very homogenous, amorphous sample containing no roots or fibres. There is no free water emitted upon squeezing, and almost all of the sample escapes the hand.

10 - Very rare to non-existent in non-sedimentary peats. In sedimentary peats, the particle size can be extremely small resulting in "pudding-like" homogenous material. Upon squeezing, all of the sample escapes the hand.

IMPORTANT CONSIDERATIONS

When using the colour of the water emitted from a sample to help in determination, it is important to note that it must be the initial, or free water that is looked at, from an unsqueezed sample. As the sample is squeezed more and more, this is "humifying" the sample and thus water emitted is not going to reflect the initial state of the peat.

It is important to "release" as much water as possible from the sample before the final squeeze determination is made, otherwise a much higher humification value will result. This is done by squeezing the sample in the hand gently, as opposed to the "final squeeze" which is firm.

As mentioned above, the action of squeezing the sample in the hand will humify and disturb the sample (especially the higher humifications) such that the least amount of initial squeezing to get the most water out, is necessary.

The initial water colour test has a number of drawbacks, the main one being that the colour of the water, especially in the more humified peats, depends strongly on the botanical composition of the peat. For example, even a small amount of charcoal in the peat will turn the water darker. This test can be used, but it is very limited. As far as we are concerned, the other indicators (texture, distinguishability of plant remains, and the final squeeze test) are sufficient for the determination of the von Post degree. It is important that all of these indicators are used together to determine the degree of composition.

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